

THE LESIONS ASSOCIATED WITH GUNSHOT WOUNDS OF THE STOMACH.*

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FIFTEEN years ago reports of cases of perforating wounds of the abdomen invariably led to a discussion of the advisability of operative interference, and the proper time after the receipt of the injury for such intervention. To-day, no such discussion is in place. In civil practice it has been definitely decided that active surgical interference is imperative, although the experience gained in the Spanish-American, the Boer,^{1 2} the Japanese-Chinese, and the Japanese-Russian³ wars has unmistakably shown the desirability of conservative treatment under the conditions found in military service. Furthermore, the question of when to operate is no longer considered. Immediate laparotomy as soon as the patient can be prepared is, I believe, the rule to-day in the hospitals in America and abroad.

During the last twenty years many reports have appeared of results of the operative treatment of penetrating abdominal wounds. These reports have generally grouped together all penetrating wounds, and the number of cases reported in each series of injuries to any one viscus has not been large. In recent years there has been a tendency to class together cases of injury to each viscus, and to consider separately the mortality and treatment of wounds of liver, stomach, diaphragm, lungs, intestines, kidney or pancreas. Such studies have the great advantage of directing the attention to the peculiarities of the wounds of each organ, and the difficulties likely to be encountered in their treatment. There is, however, the disadvantage, in gunshot wounds at least, that isolated visceral injuries must necessarily be uncommon, and that in the dis-

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cussion of the lesion to one viscus, equally or even more important associated injuries to neighboring organs are but little considered. For example, a classification which groups under the title of gunshot wounds of the stomach a case in which the bullet has passed through the diaphragm, the lung, the stomach, the transverse colon, and has remained embedded in the pancreas, is obviously unsatisfactory. The stomach injury is no more accountable for the fatal outcome than the associated lesions to lung, colon and pancreas.

My attention has been called to this feature by three cases of perforating wound of the stomach which I have operated on at the Roosevelt Hospital, the first in the service of Dr. Weir several years ago, the second and third recently in the service of Dr. Blake.

CASE I.—This I refer to only for the purpose of contrast. The wound was not caused by a bullet. A young man was stabbed with a knife in the epigastrium. A few hours after the injury the abdomen was opened; a perforation of the anterior wall of the stomach was closed with sutures, and the patient made an uninterrupted recovery.

The second and third cases, both gunshot wounds, I report in detail.

CASE II.—On December 19, 1906, at six P.M., a Chinaman, twenty-three years old, was brought to the Roosevelt Hospital. He had been shot one hour before. He was preparing, at the time, his evening meal, having taken food last at eleven A.M. The shot was fired at a distance of five yards; the weapon used was a 32-calibre revolver. The patient did not vomit or lose consciousness, but bent double and complained of epigastric pain. On admission, his respirations were 36; pulse, 108; temperature, 99° F.

There was a bullet wound over the sixth intercostal space, 7.5 cm. below the left nipple, a little mesial to the mammary line and 9.5 cm. from the midsternal line. There was no wound of exit. A small roundish mass could be indistinctly felt beneath the skin, 2 cm. to the left of the spinous process of the twelfth dorsal vertebra.

The patient was not in shock, nor did he show signs of severe hæmorrhage. There was tenderness and rigidity over the upper part of the abdomen on the left side.

Operation at eight P.M., three hours after receiving the injury. Under ether anæsthesia the abdomen was opened by an incision 15 cm. long, over the lateral border of the left rectus. There was a moderate amount of blood in the peritoneal cavity. The stomach, which was retracted beneath the ribs, was drawn down, and a perforation was discovered in the anterior surface high up on the fundus. The hole was round, as if punched out. The lesser sac was opened and the posterior surface explored; no wound was found. On more extended examination a second opening was discovered on the anterior surface behind the first perforation. This hole was irregular in shape, and considerably larger than the first. In the manipulations a small amount of the stomach contents escaped. Both perforations were closed with purse-string sutures of silk, and second reinforcing sutures of catgut. The spleen was explored and found uninjured. There was considerable hæmorrhage through the bullet wounds in the diaphragm, apparently coming from the thoracic cavity; and on each respiratory movement air and blood were sucked through these openings. The abdominal cavity was thoroughly irrigated with warm salt solution and the abdominal incision closed without drainage. A second incision was then made over the eighth rib in the axillary line, and one inch of the rib was resected and a tube introduced. Duration of operation, fifty-five minutes.

Immediately after operation, the temperature was 98° F.; pulse, 112; respirations, 32. During the night he vomited several times. The vomitus was copious and dark brown. After this vomiting ceased. He passed flatus by the bowel the following day. The temperature reached 102° F. on the second day, and fell to normal on the fifth day.

For the first twenty-four hours he was given nothing but water by mouth; after that small quantities of milk were administered at intervals. After the fourth day he was given various Chinese soups made largely of rice. During the first four days there was a free bloody discharge from the thoracic tube, the dressing being soaked with blood. There was no respiratory difficulty. Respirations were 24 on the second day. On the third day the patient coughed up a little dark blood. The stitches were

removed from the abdominal wound on the eighth day. Primary union.

After the fifth day the temperature began to rise; on the eighth day it was 104° F. There was free sero-purulent discharge from the thoracic wound. The temperature reached normal again on the twelfth day; the character of the discharge had become distinctly purulent. There was a second rise of temperature on the sixteenth day and it was evident that the chest wound was not draining properly, the diaphragm coming in contact with the end of the drainage tube. Under ether anæsthesia two inches of the sixth rib in the mid-axillary line were removed. Temperature was normal on the twenty-sixth day.

On the seventeenth day the patient complained of pain at the point of lodgment of the bullet in the back. Under cocaine anæsthesia an incision was made over the mass near the twelfth dorsal vertebra, and a cavity was opened containing about 2 drachms of pus, the bullet and particles of clothing.

The patient is now up and about and rapidly gaining strength, eight weeks after the operation.

CASE III.—On January 14, 1907, at 9.30 A.M., a negro, thirty-eight years old, was admitted to the Roosevelt Hospital. He had been shot one hour before. He refused to tell the circumstances of the shooting; but his clothing was scorched as if he had been wounded at short range. He was in slight shock; his temperature was 98° F.; pulse, 104; respirations, 36. The wound of entrance was in the left axillary line over the ninth rib. There was no wound of exit. There were pain, tenderness and rigidity over the upper abdomen. The urine was slightly blood stained.

Operation at 10.30 A.M., two hours after the injury; under ether anæsthesia the abdomen was opened through an incision corresponding to the outer border of the rectus. The peritoneal cavity was filled with blood. An attempt was made to draw the stomach into the wound, but this could not be accomplished on account of adhesions. During the manipulations there was a gush of dark brown fluid. After long search an opening was found in the greater curvature, at the attachment of the gastro-colic omentum, two inches above the point where its direction changes from vertical to horizontal. It was closed with a purse-string suture. The lesser sac was opened through the gastrocolic omentum, and

an attempt was made to explore the posterior surface of the stomach. No opening could be found. No injury to the spleen nor to the neighboring coils of intestine was discovered. The abdominal cavity was irrigated and a cigarette drain introduced down to the stomach wound. The temperature after the operation was 98° F.; pulse, 120; respirations, 36. During the day he grew gradually weaker, his pulse became more rapid, his temperature rose to 104° F. He died at 3.30 A.M., evidently from hæmorrhage, sixteen hours after the operation.

At autopsy dense adhesions were found in the neighborhood of the spleen. There were two perforations in the stomach; one firmly closed by suture in the greater curvature, the second about one inch from it, on the posterior surface. There was a large retroperitoneal hæmorrhage, the bullet having passed through the upper pole of the kidney. It was lodged in the muscles of the back. There were signs of beginning peritonitis.

In all these patients the stomach was perforated, but the gravity of the injury in the second and the third cases depended on the complicating visceral lesions.

It has, therefore, seemed to me of interest to study the injuries which are likely to be associated with gunshot wounds of the stomach and to see if any deductions can be drawn as to the influence of these on mortality, and any guide obtained for treatment.

As pointed out by Forgue and Jeanbrau,⁴ the stomach is so surrounded by other structures that a gunshot wound of that organ alone is almost impossible. They call attention to the fact that lying, as it does, in the hollow of the diaphragm, which separates it from the left pleura and lung, the pericardium and heart, being partly covered by the liver and resting on the pancreas, kidney and suprarenal and spleen, with the transverse colon and coils of the small intestine below it, there is only one small area in front, where, when moderately distended, it comes in contact with the anterior abdominal wall. They show some admirable diagrams taken from Testut's Anatomy, and reproduced by Moynihan in his book on abdominal operations.

They also show by colored plates the surface areas, anteriorly and posteriorly, of gastric vulnerability. The anterior area lies to the left of the median line; its upper limit corresponds to the dome of the diaphragm, which reaches in the mammary line the fifth rib. The lower limit is a line passing through the junction of the ninth and tenth costal cartilages of each side. The posterior area is oval in shape, with the long axis of the oval slightly inclined toward the vertebral column. It reaches from the eighth rib in the left scapular line, to the level of the spinous process of the second lumbar vertebra. Fully two-thirds of this area of vulnerability falls within the limits of the thorax; that is, a bullet, to reach the stomach, must pass through the chest wall and the diaphragm. The stomach being a movable and dilatable organ, and the various structures in contact with it varying in volume from time to time, it is obvious that this area must be constantly changing. It is only true when the stomach is moderately distended.

They emphasize these points in topographical anatomy to show that it is difficult to wound the stomach without injuring surrounding structures, and point out that in a series of one hundred and twenty-six cases of gunshot wound of this organ thirty-two times only was there no associated injury. This proportion would be even less if they had considered wounds of the pleura and diaphragm as complicating injuries.

They find that the mortality varies with the time of intervention and co-existing injuries, and show from their series a mortality of 42 per cent. in uncomplicated cases and of 68 per cent. in cases complicated by other visceral injuries. Their table includes a number of cases reported from fifteen to twenty years ago.

One would expect a lower mortality in gastric perforation without associated injuries, for the chyme is a bad culture medium for pathogenic organisms, and the contents of the fasting stomach, it is said, are relatively sterile.⁵ It would seem that when the operation is performed a few hours after the receipt of the injury most of the patients should recover. Such I believe to be the case in uncomplicated stab wounds of

the stomach. The chief danger in these cases would be hæmorrhage, and to less extent peritoneal infections introduced from without.

In gunshot wounds of the stomach two elements of danger are added. A bullet nearly spent may pass through one wall of the stomach and may bruise the mucosa without again perforating. There may be no evidence of this contusion externally, or there may be an area of ecchymosis. Such bruised areas may cause immediately a fatal hæmorrhage, or, as in Forgue's interesting case, the hæmorrhage may come on later, after the formation of an actual ulcer. His case is a rare example of uncomplicated gunshot wound of the stomach, operated on within one hour of the receipt of the injury and with a fatal outcome. No other structure of importance was injured, neither the diaphragm, the pleura nor any viscus. The bullet (7 mm.) passed through the abdominal wall in the epigastric region. The shot was fired at close range, but at the laparotomy which was performed one hour after the injury only one perforation was found in the anterior wall of the stomach. The perforation was sutured and the abdomen closed. The patient did well for two days. On the third day he vomited blood several times, his pulse became weak and he died with symptoms of internal hæmorrhage. At autopsy the peritoneum was normal and the anterior perforation was found firmly closed. The stomach and small intestine were filled with blood. On the posterior surface of the stomach there was an area of ecchymosis about 5 cm. in diameter. At its centre the mucosa had disappeared and the wall was much thinned. Histological examination showed lesions analogous to those found in beginning ulcer of the stomach. The bullet was found within the stomach.

Such cases must be very unusual. Fertig,⁶ in a recent article on traumatic ulcer of the stomach, does not mention gunshot injuries among the causes of this condition.

In a few other instances the bullet has remained in the stomach and has been subsequently vomited or passed by the bowel. In still other cases the bullet has not actually pene-

trated the stomach cavity, but has torn, in its passage, a hole or gutter in the stomach wall. In most instances, however, there has been a wound of exit as well as a wound of entrance, and the failure to detect, at the time of operation, this second opening constitutes another danger peculiar to bullet wounds of the stomach.

Frisch⁷ has reported a case of this kind, followed by recovery, the X-ray showing the bullet in the muscles of the back, and has collected five similar cases, all of which are included in Forgue's series. He has proved experimentally that the wound of exit made by bullets of small calibre may be an irregular H- or V-shaped tear, and that the rent in the serosa is often difficult to detect even on close inspection.

M. Auvray,⁸ who has operated on seven patients with perforation of the stomach, in describing three recent cases before the 19th Congress of the French Surgical Association, October, 1906, emphasized especially this difficulty. He advised a large opening in the gastrocolic omentum, and, as it was often insufficient, considered the indications for exploratory gastrotomy.

The failure, however, to suture the bullet hole in the posterior wall of the stomach has not materially influenced the mortality. Still, in two instances, it was followed by a subphrenic abscess, and although the patients recovered, convalescence was much delayed, and there are two instances in Forgue's series where failure to close a second opening on the anterior surface was followed by peritonitis and death.

In a series of twenty-five cases reported since 1903, there is no instance in which this accident caused death. Auvray's, Frisch's, Kroner's, Zawadzki's and Jordan's patients all recovered, and in the other instances death resulted within a few hours from hæmorrhage due to associated visceral injuries.

However fortunate one may be in escaping the consequences, an operation cannot be considered satisfactory which leaves unsutured a gastric perforation. A simple method of testing the integrity of the posterior stomach wall might be carried out in the following manner. As soon as the bullet

wound is found in the anterior wall, a purse-string suture of silk is passed about it in the usual way. A rubber tube is then introduced into the perforation, the suture tightened firmly about the tube, and a single knot tied and held by a clamp. If a hole be torn through the gastrocolic omentum, and salt solution introduced through the tube into the stomach, one should be able to appreciate readily whether the solution is escaping into the lesser cavity. If such prove to be the case, then the opening in the omentum may be enlarged by dividing, widely if necessary, the gastrocolic omentum, as suggested by Forgue. If there be no escape it is reasonable to suppose that there is no opening or an opening too small to be likely to cause a dangerous leakage. The tube can then be withdrawn from the anterior opening, the purse string drawn together and tied, and the reinforcing sutures introduced.

This method would have the obvious disadvantage that the stomach contents, should there be a perforation, might be forced into the lesser sac, still further contaminating it. But the advantage of being able to tell with certainty whether there is a second perforation seems to me to outweigh this objection.

Of these two dangers peculiar to bullet wounds of the stomach, the first, hæmorrhage from erosion of the mucosa from a spent bullet, rarely occurs; and the second, the difficulty in finding the wound of exit, seems to be only to a small extent responsible for the fatality of the injury.

The records of cases published fifteen or twenty years ago, in which no operations were performed, show clearly that associated visceral injuries were in most instances the cause of death. As has been previously stated, one would expect on anatomical grounds a gunshot wound of the stomach to be almost always accompanied by injuries to adjacent structures, and if one considers wounds of the diaphragm, lung and pleura as complicating injuries, then an isolated injury of the stomach is very uncommon. In examining the cause of death in thirteen cases tabulated by Forgue as treated expectantly and as being without complicating visceral lesions, in one

instance death occurred within a few hours from hæmorrhage, the sixth interspace close to the sternum border having been perforated. There is no note as to whether the hæmorrhage was thoracic or abdominal. In a second case, death occurred at the end of several days; in the autopsy notes it is stated that there was neither hæmorrhage nor peritonitis. In a third, in which the wound was caused by a bullet from a revolver, 7 mm., at close range, the wound of entrance being in the seventh interspace, death occurred in two days. The autopsy showed the left lung retracted and the pleural cavity half full of a putrid, watery material mixed with particles of food. The bullet had perforated the pleura, the diaphragm, the stomach in three places, again the diaphragm, and was found lodged in the body of the eleventh dorsal vertebra. The spleen, heart and pericardium were uninjured. There was no peritonitis. In two instances, death occurred from peritonitis; in another, death occurring four months after the injury, the stomach wound was found firmly cicatrized. So, in this series reported as without complications, in only two cases was the fatal outcome due to gastric injury.

A perusal of the cases reported in the second series, in which are grouped cases with complicating visceral injury, shows that in nearly every instance death was due to the associated injury. In several, in which the patient had lived for a number of days, the wound in the stomach had healed, in one instance death being due to an abscess in the liver. In a second case, reported by Rostowzew,⁹ the wound of entrance was in the seventh interspace, between the parasternal and mammary lines. There were no abdominal symptoms. On the fourth day it was necessary to aspirate the chest on account of symptoms of asphyxia; on the sixth day foul-smelling bloody fluid was escaping from the bullet wound; on the eighth day the patient died. The post-mortem examination showed two healed wounds in the stomach and a small blood clot and fibrinous exudate on the neighboring serosa. The bullet had passed through the diaphragm, the stomach, and the lower lobe

of the left lung. Death was due to the thoracic complications, not to the injury to the stomach.

In another instance there were wounds of the kidney, the pancreas and the inferior vena cava. Death had occurred in a quarter of an hour.

A further study of gunshot wounds over the area of gastric vulnerability includes, therefore, an inquiry into the associated visceral injuries. As pointed out above, the greater part of this area lies within the limits of the thorax; therefore in the majority of cases there will be a wound of the thoracic wall and diaphragm; in many cases, of the pleura and lower lobe of the left lung.

Such wounds may cause hæmorrhage in the thoracic cavity, and are usually treated by careful cleansing of the surrounding skin, an occlusive dressing applied to the wound and complete rest. The resulting hæmothorax is treated by aspiration as soon as signs of dangerous compression appear. Such hæmorrhage into the chest may come from the thoracic wall, one of the intercostal arteries being divided, or from the lung itself. When it is from the lung, it is believed that the blood collecting in the rigid thorax helps to check the hæmorrhage by exerting pressure on the pulmonary tissue, and one is cautioned not to aspirate until the wound in the lung is closed, lest the hæmorrhage should again be started.¹⁰ It is also generally assumed that the collapsed lung bleeds less than the expanded lung, or that in a given time less blood actually flows through it than normally, and it has even been suggested that the chest should be widely opened, with the idea of checking the hæmorrhage by causing the collapse of the lung. Sauerbruch,¹¹ however, has proved experimentally that in unilateral pneumothorax more blood flows through the collapsed lung than through the same lung before the pneumothorax was established. He finds that there is a hyperæmia of the collapsed lung.

In whatever manner one may interpret the complex phenomena found in the alteration of normal pulmonary conditions, the production of a pneumothorax does not come into

consideration in the class of injuries under discussion. As soon as the abdomen is opened for the purpose of suturing the stomach, air is sucked through the bullet holes in the diaphragm and the lung collapses, if it has not already done so, and a pneumothorax is established.

In a series of experiments, Noetzel¹² has shown that the pleura under physiological conditions is very resistant to infection. If, however, important physiological relations are altered by the entrance of air into the pleural cavity, then the resistance is greatly reduced. The introduction of infectious material into the pleura, when a pneumothorax was established, was invariably followed by an extensive empyema.

If there be any escape of stomach contents during the manipulations of an operation or if there has been any beforehand, particles may readily be drawn through the wounds of the diaphragm into the thorax, and another element may be added to a hæmopneumothorax. It has been previously stated that the chyme is relatively free from pathogenic microorganisms, and the infection which has been shown to follow in some cases may have been introduced into the pleura by particles of clothing or other material carried in by the bullet, the foreign matter from the stomach simply adding to the conditions favorable to bacterial life.

It would seem, therefore, that in certain cases with a well established hæmopneumothorax, drainage of the chest was desirable.

It might with justice be urged that, after suture of the diaphragmatic wound and closure of the abdomen, the pneumothorax would speedily disappear and that it would be legitimate to wait to see whether a severe infection of the thorax would follow. However, conclusions drawn from thoracic injuries uncomplicated by a wound of the diaphragm are, I believe, misleading, and in the second case reported, when I opened subsequently an abscess in the back containing the bullet and particles of clothing, I was satisfied, in this instance at least, that drainage of the thorax was desirable, and it seemed to me that the resulting empyæma was less extensive and the conva-

lescence shorter than if the thoracic condition had been treated expectantly.

Much attention has been devoted in recent years to wounds of the diaphragm, to their treatment, and to the possibility of diaphragmatic hernia.^{13 14} The impetus to this study has been furnished largely by Italian surgeons, who have unusual opportunities for studying and treating stab wounds, and the majority of cases reported have been stab wounds, not gunshot wounds. Among seventy-three cases reported by Suter,¹⁵ five only were gunshot wounds, and of these, one was caused by a charge of shot; in a second case a fractured rib tore the diaphragm; in a third the weapon was a rifle and the injury was inflicted apparently at close range; and in a fourth the ensiform cartilage was hit, tearing the insertions of the diaphragm.

It is evident that gunshot wounds of the diaphragm heal, for diaphragmatic hernia is very uncommon notwithstanding the number of thoracic injuries received in battle. It is also obvious that an incised wound, if it pass through diaphragm at right angle to the course of its fibres, would gape more than a bullet wound and would be much more likely to be followed by diaphragmatic hernia. In the only instance of such injury that I have seen, a large piece of omentum was protruding through the chest.

An observation by F. König¹⁶ shows the manner of healing in gunshot wounds. In this instance the wound of entrance was in the fifth interspace near the mammary line, the wound of exit about an inch to the left of the tenth dorsal vertebra. The abdomen was not open. The chest was aspirated several times. The patient died on the forty-fourth day. The autopsy showed that the pericardium, which had been grazed by the bullet, was adherent to the heart and firmly bound by dense adhesions to the diaphragm. The bullet had passed through the liver and grazed the stomach, causing a traumatic ulcer. There were multiple hepatic abscesses. It passed again through the diaphragm, tearing irregularly the muscle fibres, and finally through the pleura and lung. The pleural surfaces over the

bullet opening in the diaphragm were firmly united by dense adhesions completely sealing the opening.

There are, however, a few cases reported of hernia following gunshot wounds. Bardenheuer,¹⁷ in 1879, gave the details of an autopsy on a man who had been shot eight years before, and whose death had been caused by a strangulated diaphragmatic hernia through the old bullet wound. Robert¹⁸ reports the case of a man shot in the sixth interspace by a revolver bullet of 7 mm. He recovered. One year later death occurred from an intestinal obstruction. The autopsy showed a hernia through the diaphragm.

There is, therefore, a real danger from bullet wounds of the diaphragm, and such wounds, if accessible, should be sutured.

Injury to the liver has been the most frequent visceral complication, and the wound has usually been of the left lobe. The hæmorrhage has not, as a rule, been profuse; only one fatality can be attributed to it. In a number of cases the liver wound was closed by suture; in two, hæmorrhage was checked by packing; in another, the bullet passed through the gall-bladder, which was excised.

The spleen has been injured a number of times. In a recent article on traumatic lesions of this organ, Noetzel¹⁹ has emphasized the necessity of the removal of the spleen wherever the organ is much damaged, calling attention to the fact that sutures do not hold in the friable splenic substance. This difficulty in suturing the spleen is mentioned in a case reported in Forgue's series. The splenic wound was finally packed and the patient recovered. In another instance the wound in the spleen was unrecognized at the operation undertaken for the gastric perforation. Death resulted on the seventh day. At autopsy a wound was found in the upper pole of the spleen. There was a perforation of the diaphragm and a litre of blood in the left pleural cavity, as well as a wound of the lower lobe of the left lung. In a third case the splenic wound was cauterized, the patient dying in a few hours. In a fourth case the spleen was removed; death occurred two days later. The

spleen was injured in four of the cases in the series I have tabulated. In two, the spleen was removed; in a third a Mikulicz tampon was introduced; in the fourth the injury was slight. All recovered.

The pancreas is reported as injured in eight instances in Forgue's series of eighty-one cases in which an operation had been performed and perforation of the stomach found. In seven instances the patient died. In all these there were other severe complicating lesions. One patient recovered. In this case the wound in the pancreas was packed and drainage introduced. There was an escape of pancreatic juice for several days. Death occurred in most of the fatal cases within twenty-four hours, apparently from hæmorrhage; in one instance not until the eighth day. In this case, at autopsy the entire bullet track, and the pancreas itself, were found gangrenous. There had been but little attempt at repair.

Borchardt ²⁰ has collected fifteen cases of gunshot wounds of the pancreas. Six were taken from the older records, at a time when penetrating abdominal wounds were not operated on, and in every instance death resulted. Of the nine cases operated on, the stomach was perforated in three; they appear in the series already discussed. Suture of the pancreatic wound and the introduction of drainage is the treatment recommended. There were five recoveries and four deaths in this series of cases.

Becker, ²¹ in reporting an unusual case of isolated gunshot wound of the pancreas, calls especial attention to the introduction of drainage in these cases as a means of avoiding the peculiar fatty or pancreatic necrosis. In his case the bullet grazed the stomach without perforating it, and no other viscus was injured. The patient recovered.

The records show that in eight instances the bullet, after passing through the stomach, wounded the upper pole of the kidney, causing usually a large retroperitoneal hæmorrhage. Six of the patients injured in this way died; two recovered. In one case two perforations of the stomach and one of the transverse colon were closed with sutures, and a large retro-

peritoneal hæmatoma were noted; but apparently no treatment directed toward the kidney was carried out. There was hæmaturia for several days following the operation. The patient recovered. In two instances the kidney was removed, and in both the outcome was fatal. In Riese's case reported in my series, the twelfth rib was resected and the wound in the kidney packed. The patient recovered. In several instances the wound of the kidney and the retroperitoneal hæmorrhage were only made evident at autopsy.

Perforations of the small intestine and transverse colon are recorded among the complicating visceral injuries in sixteen cases. In one instance there were eleven perforations of the small intestine and two of the colon. In several there was a single perforation. Eight of the patients recovered. In most of the instances with a fatal outcome, there were a number of holes in the intestine.

From this inquiry into the associated lesions of gunshot wound of the stomach, the conclusion may fairly be drawn that the complicating lesions are in most instances of graver importance than the gastric injury, and that to speak of the high mortality of gunshot wounds of the stomach is misleading. In any gunshot wound, it is the sum of the injuries inflicted on the different organs and structures which is responsible for the gravity of the condition.

To-day, when it is the rule to operate immediately, there is little opportunity of making an accurate diagnosis of the organs injured; one cannot wait for vomiting of blood, or even for the onset of rigidity in the abdomen. The situation of the small perforating wound furnishes the only guide. If this is over the area of gastric vulnerability extending on the left side from the level of the fifth rib in the mammary line to a line passing through the extremities of the tenth rib, anteriorly; and from the eighth rib in the scapular line to the level of the spinous process of the second lumbar vertebra, posteriorly, then one may expect a number of important organs and structures to be wounded; and it seems to me of practical advantage to think of the injuries recorded in similar cases.

It is obvious that a shot may enter the body at any angle, and without a wound of exit, and in the absence of an accurate history one may be unable to determine the course of the bullet. Fortunately, the bullet is often to be felt in the subcutaneous tissue, the force of a bullet from a revolver (.32 or .38 calibre), the weapon most frequently used, being sufficient to drive the bullet through the body as far as the tough and elastic skin of the other side. In any event, doubt as to intervention would only arise when the entrance wound was near the upper limit of this region.

In an operation undertaken for a wound in this area it is necessary to think of all the structures likely to be injured and to be prepared not only to suture a wound in the stomach, but to treat any of the associated injuries. And a reduction in the fatalities should go hand in hand with the recognition and treatment of these complicating lesions. In the twenty-five cases which I have tabulated this is clearly shown. In most of them there were associated injuries of graver significance than the stomach injury; in two, splenectomy was performed; in two, thoracotomy as well as laparotomy; in five, the diaphragm was sutured; in one, the twelfth rib was removed and a wound in the kidney packed; in another the gall-bladder was excised. There were six deaths and nineteen recoveries, or a mortality of less than 25 per cent. Most of the cases were operated on within a few hours of the receipt of the injury, the longest interval being eighteen hours. In this instance the patient recovered.

This mortality represents, not deaths occurring from gunshot wounds of the stomach, but those resulting from injuries inflicted by bullets passing through the area of gastric vulnerability.

It would be interesting to contrast these injuries with gunshot wounds over the area of hepatic vulnerability.

It might be urged that only favorable cases are published. These cases, however, have been taken, in most instances, from records of all penetrating gunshot wounds reported in a given period from the hospital services of various surgeons.

ABSTRACT OF REPORTED CASES OF GUNSHOT WOUNDS OF THE STOMACH SUBJECTED TO OPERATION.

Number.	Reference.	Age, Sex, Nationality.	Weapon, Distance, or 5 metres.	Interval between injury and operation.	Wound of Entrance; Wound of Exit.	Operation.	Injury to Stomach.	Associated Injuries.	Result.
1	M. Auvaury, Assoc. Franç. de Chir., XVI Congrès, 53, p. 341.	31; M.	Revolver: 4 or 5 metres.	2 hrs.	Left costal border, above navel, to the interspace. No exit wound.	Median laparotomy.	In greater curvature, 3 cm. above point where greater curvature passes from vertical to horizontal. No wound of exit. No wound of suture.	Diaphragm.	Recovery.
2	K. Barschley, Ill.-Irisp. Z. klin. Chir., LXXVIII, p. 377, 1906.	15.	Two paces.	18 hrs.	Two fingers breadth above navel, to the right of linea alba. No exit wound.	Median laparotomy.	In middle of lower border of stomach. Sutured. Second hole on posterior surface not far from suture.	Bullet found in hilus of spleen. Nikulitz tampon applied to hilus. Removed on tenth day.	Recovery.
3	O. Brehm, Arch. f. klin. Chir., LXXIII, p. 734, 1904.	40; F.	Revolver.	2 hrs.	Left hypochondrium. No exit wound.	Median laparotomy.	In greater curvature. Sutured. No wound of exit discovered.	Gutter in left lobe of liver, 2 cm. long. Sutured.	Recovery.
4	Idem, Case XVII.	26; F.	Revolver	2½ hrs.	Eight left intercostal space in mammary line. No exit wound.	Median and transverse laparotomy.	Perforation anterior surface of stomach, 10 cm. from lesser curvature posterior surface. Suture.	Gutter in left lobe of liver and lesser curvature of stomach from splenic artery. Ligated. Spleen removed; tampon. Subphrenic abscess.	Recovery.
5	J. V. Brown, St. Louis Courier of Med., v. xxxiii, p. 9, 1905. Case I.	30; M. Italian.	Revolver: close range.	1 hr.	Below left costal border, between ninth and tenth ribs on right side. No exit wound.	Median laparotomy.	Two openings near pylorus. Closed by suture. Suture.	Right lobe of liver near lower border perforated, packed with iodoform gauze, perforated. Cholecystectomy.	Recovery.
6	F. D. Fouger, Ann. Med. Leg., LXXXV, p. 35, 1902. Case VI.	27; M. Negro.	Not stated.	Not stated.	Tenth rib in left axillary line. No exit wound.	Median laparotomy.	"Good-sized hole in cardiac extremity. Suture."	Laceration of under surface of left lobe of liver. Sutured. Large abscess of spleen. Hole in diaphragm. Sutured. Bullet found in folds of the gastrocolic omentum.	Recovery.
7	O. V. Frauch, Arch. f. klin. Chir., LXXIII, p. 556, 1904.	25; F.	Revolver: three paces.	3½ hrs.	Left mammary line, below border of rib. No exit wound.	Median laparotomy.	Small opening in anterior surface between cardiac and pyloric openings, lesser than greater curvature. Suture. Careful search failed to find second opening.	Left lobe of liver perforated by bullet. X-ray subsequently showed bullet in lumbar region.	Recovery.

8	Robert W. Johnson, N. Y. Med. Jour. nal, v. lxxix, p. 188, 1904.	18: mulatto.	Revolver; 32 calib.	1 hr.	Near median line in epigastrium. No exit wound.	Laparotomy.	Wound in greater curvature, 5 cm. in length. Sutured.	Bullet passed through liver. Wound closed with sutures.	Recovery.
9	Amund, Med. v. ix, p. 1024, 1905.	21: white.	Revolver; 38 calib.	2 hrs.	Between ensiform and navel. No exit wound.	Laparotomy through bullet wound.	Perforation near lesser curvature. No wound of exit found.	Bullet passed through liver.	Recovery.
10	Idem.	Negro.	Not stated.	8 hrs.	Left linea semilunaris, near costal margin.	Laparotomy, left lateral.	Two perforations on anterior surface. Suture.		Death 4 hrs. after operation.
11	M. Krieger, Arch. f. Klin. Chir., v. lxxv, p. 643, 1905.	38.	Revolver; 7 mm. close range.	2 hrs.	Sixth interspace, 1 cm. external to mammary line. No exit wound.	Laparotomy, left lateral.	At fundus large perforation. Suture. No other opening found.	Subphrenic abscess, followed by empyema.	Recovery.
12	Idem. Case XIII.	19.	Pistol; 1½ ft.	2 hrs.	Below sixth rib to left of mid-line.	Laparotomy.	Anterior hole near cardia, posterior hole in similar position.	Wound of liver. Sutured. Subphrenic abscess.	Recovery.
13	Idem. Case XVIII.	35.	Revolver; close range.	13 hrs.	Sixth interspace, ext. to mammary line. Exit wound between breast and angle of scapula.	Laparotomy.	Hole near lesser curvature. Sutured. No other opening found.	Wound of liver. Sutured. Death following day. Autopsy showed second perforation of stomach posterior to first. Abscess perforated pericardium and spleen.	Death.
14	W. Martin, Case II.	23: Chinese	Revolver; 32 calib.; five yards.	3 hrs.	Mesial to mammary line. Sixth interspace. No wound of exit.	Laparotomy, lateral.	Two holes in anterior surface. Closed by suture.	Wound of lung. Blood in pleura, thoracotomy and drainage.	Recovery.
15	Idem. Case III.	38: negro.	Revolver; 38 calib.; close range.	2 hrs.	Left axillary line over eighth rib. No exit wound.	Laparotomy, lateral.	Hole in greater curvature. Sutured. No other perforation discovered.	Left kidney. Death sixteen hours after operation, from retroperitoneal hemorrhage. At autopsy second opening discovered.	Death.
16	Riese, XXXIII, Verh. d. Verein. der Deutschen Chir., v. xxxiii, p. 69, 1904.	20: F.	Revolver; 7 mm.	3 hrs.	Left costal margin parasternal line, bullet felt under skin in scapular line, between seventh and twelfth ribs.	Median laparotomy, and over twelfth rib in lumbar region.	Entrance wound near cardia. Long search for exit wound. Both sutured.	Left hole of liver. Wound sutured. Diaphragm sutured. Subperitoneal resection of twelfth rib. Wound in kidney 5 cm. long, packed. Wound 5 cm. long, packed.	Recovery.
17	E. C. Richel, Surg. Gynecology and Obstet., vol. iv, Case VII, 1907.	Negro.	Revolver; close range.	Not stated.	Sixth interspace, midway between mam. and axillary line.	Median laparotomy.	Two perforations in fundus, anterior and posterior, a little above level of cardia. Suture.	Diaphragm wounded, unsuccessful attempt to suture. Death in twelve hours from hemorrhage. Autopsy showed bullet in right lobe of liver. Some hemorrhage in left pleura.	Death.

ABSTRACT OF REPORTED CASES OF GUNSHOT WOUNDS OF THE STOMACH.—Continued.

Number.	Reference.	Age, Sex, Nationality	Weapon, Distance.	Interval between Injury and Operation	Wound of Entrance; Wound of Exit.	Operation.	Injury to Stomach.	Associated Injuries.	Result.
18	Idem. Case XI.	German.	Revolver; 32 calibre.	Not stated.	Two shots. Upper costal wound, six sixth rib, 2 inches left of spine; lower costal wound over tenth rib.	Lateral laparotomy.	Two perforations in fundus of stomach. Bullet found in peritoneal cavity. Suture of perforations.	No other abdominal injury.	Recovery.
19	Idem. Case XV.	Negro.	Revolver; close range.	Not stated.	Centre of sternum to centre of umbilicus costal cartilage.	Median laparotomy.	Two perforations, anterior and posterior. Sutured.	Liver.	Recovery.
20	Idem. Case XVI.	Negro.	Revolver; 22 calibre.	Not stated.	Two inches to left of median line and two inches above	Laparotomy.	Anterior perforation. Sutured.	No other injury.	Recovery.
21	Savatand, Bull. de la Société de Chir. de Paris, v. xxxi, p. 845, 1905.		Revolver; 9 mm.	3 hrs.	Between ensiform and left costal margin. No exit wound.	Median laparotomy.	Two perforations in anterior wall, near fundus. Suture.	Wound of left lobe of liver.	Recovery.
22	Idem. Case XVII. Gon- Paris de Chir. Paris, 1906, p. 155.	Negro; 46.	Revolver; close range.	5 hrs.	Left costal border between ensiform and left median line.	Median laparotomy.	Perforation in ant. wall near fundus. Suture. Perforation in post. surface reached with difficulty. Both sutured.		Recovery.
23	G. T. Vaughan, Americ. Journal of Med. Science, v. xxx2, p. 285, 1906.	35; negro.	Not stated.	8 hrs.	One inch to right and slightly above ensiform. No exit wound.	Laparotomy through right rectus.	Two perforations near pylorus. Sutured.	Wound of left lobe of liver and large intestine. Died on operating table, evidently of hemorrhage.	Death.
24	Kronik, Ieksaaka, 1902, Nr. 16, Ref. Centralbl. f. Chir., 1903, p. 296.	44.	Flint rifle; close range.	2 hrs.	Ten cm. above left of median line.	Laparotomy through right lateral wall.	Perforation in anterior wall. Suture. None in posterior found.		Recovery.
25	Idem.	Soldier.	Modern rifle; close range.	4 hrs.	Near mammary line, rib to seventh rib, 3 cm. long. Stomach contents escaping from wound.	Left thoraco- lateral incision laparotomy.	Wound 4 cm. long in stomach. Sutured.	Diaphragm sutured through thoraco-umbilical opening, wound 5 cm.	Death.

In conclusion:

1. Perforations of the stomach alone should show a low mortality.
2. Uncomplicated gunshot wounds of the stomach are very uncommon.
3. The associated injuries are usually of graver significance than the gastric injury.
4. It is misleading to speak of the mortality following gunshot wounds of the stomach without considering the complicating injuries.
5. The mortality of gunshot wounds over the area of gastric vulnerability has been much reduced during the last five years, being now about 25 per cent.

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